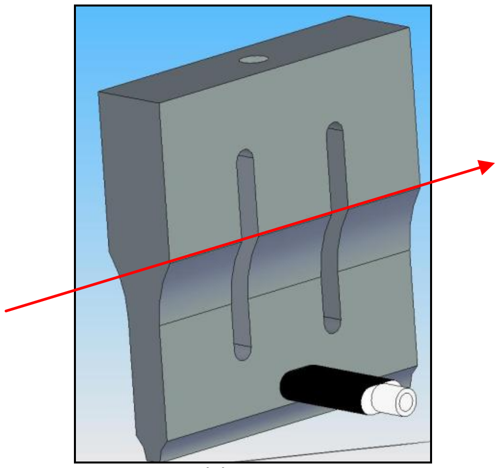
4 The measuring head USM 3.1

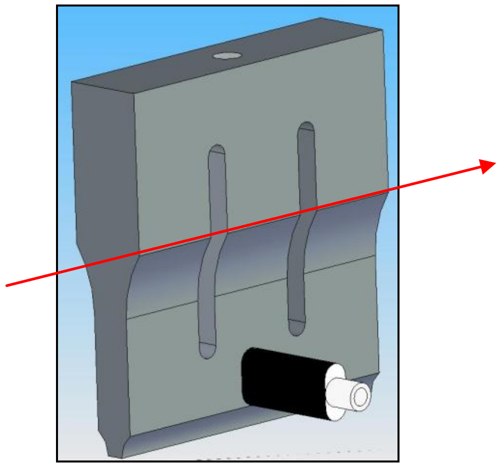
4.1 The correct use of the measuring head

The USM 3.1 sensing head is marked by a small rod-shaped elevation on its wide and narrow sides. Make sure that this marked side is always facing upward during measurement.

The sensor is held in hand and pressed against the sonotrode with a low pressure. The display of the oscillation on the oscilloscope is obtained by means of horizontal or vertical orientation, respectively.



Measurement of the transverse oscillations



Measurement of longitudinal oscillations

Never allow the welding unit swing in disassembled or partially assembled state, e.g. without a sonotrode. Only allow a welding unit to swing in complete state, with all components (converter, booster and sonotrode), to prevent damage to components!

4.2 Interpretation of the measurement results

There are no binding requirements for the quality of sonotrodes, since the sonotrode had to be adapted very specifically to welded parts under certain circumstances, so that it was not possible to design an optimal sonotrode geometry with optimal oscillation properties.

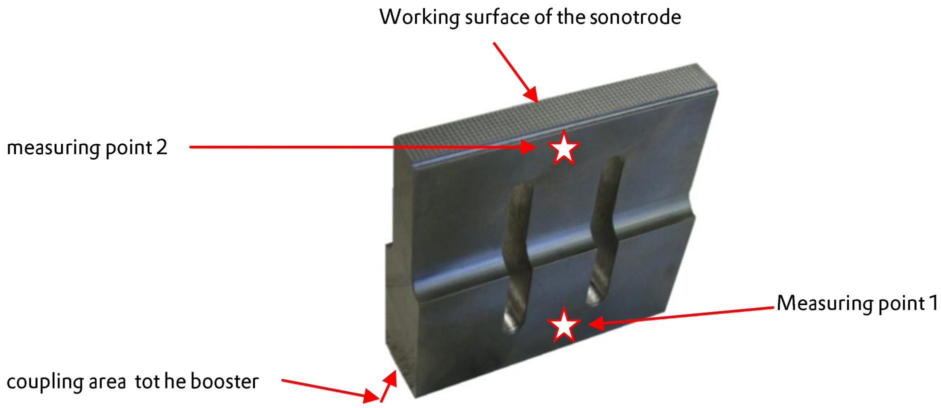
The general rule is that a sonotrode should have significant lower transverse oscillations than longitudinal oscillations, particularly at the level of the working surface. In addition, every sonotrode should have a distinct zone of low longitudinal waves in the vicinity of its zero point. In the above figures, the zero point is located at the centre of the sonotrodes, at the transition from the "thick" part to the radius (see the red arrows)

The oscilloscope only outputs a digital value for the amplitude that is unrelated to an absolute amplitude value. Only the comparison of two measuring points allows statements about the actual amplitude.

4.3 Determining the gear ratio

based on the following sample measurement:

You want to check the "gear ratio" of your sonotrode. This refers to the value by which the "input amplitude" (measured at the edge of the coupling surface to the booster) increases (measured at the edge of the working surface).



Divide the displayed digital value of measuring point 1 by that of measuring point 2. Then you get the value of the transmission ratio.

Example:	measuring point 1	= **70**
	measuring point 2	= **50**
Division:	$\frac{70}{50}$	= **1.4**
Gear ratio:		= **1 : 1.4**

During the measurement you should take care that the smallest possible fluctuations in the curve occur and that you reach the largest amplitude. Try to keep the probe as steady as possible until the display shows relatively constant values.

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4.4 Meaningful measurements

Using the same procedure as described above (4.3), you can make the following measurements that allow you to make statements about the quality of your sonotrode:

4.4.1 Gear transmission ratio (see above under 4.3)

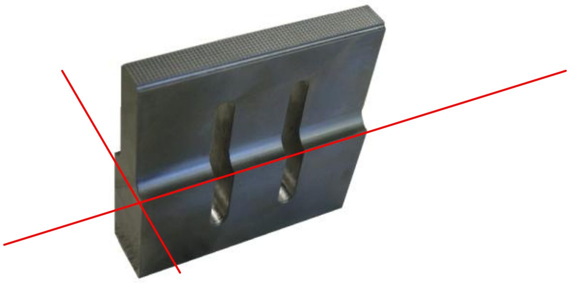
4.4.2 Zero-line

Amplitudes as the measured values of a sound wave can be visualized with the measuring head USM 3.1 and an oscilloscope. They follow a sinusoidal curve.

Low and high points of the sine curve mark the areas of greatest or smallest extent. The passage through the zero line correspondingly marks the zone with no or minimum extension. For physical reasons, the geometric reduction stage is placed in this zone to increase the amplitude.

The zero line or the zone of lowest amplitudes is an absolute must and absolutely necessary.

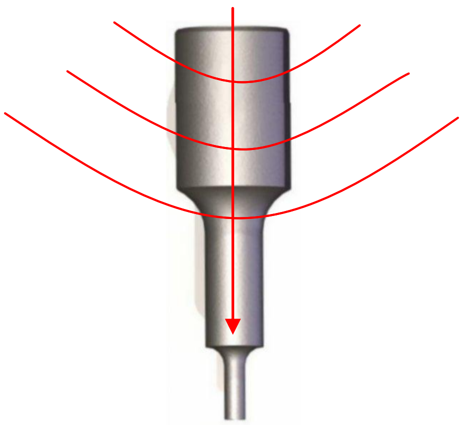
With the measuring head USM 3.1, the sonotrode can be "sensed" and the amplitudes can be made visible: the input amplitude, the - usually larger - output amplitude, and the "zero amplitude" of the zero line.



Routes zero line

The absence of the "zero line" indicates on a faulty construction of the sonotrode.

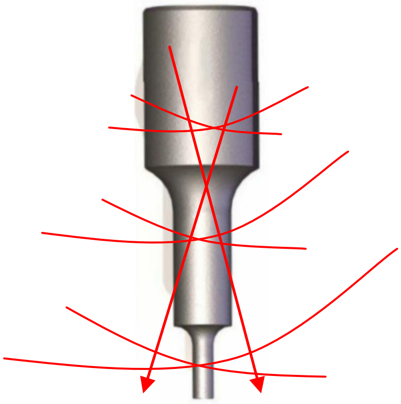
4.4.3 Ratio longitudinal to transversal vibration



typical longitudinal sound wave course

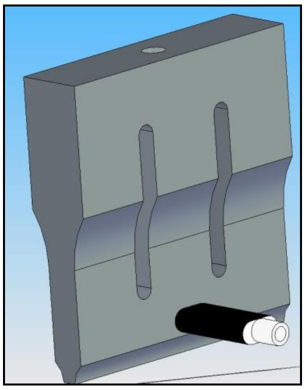
In most applications in ultrasound processing, so-called longitudinal ultrasonic waves of the ultrasound are desired. An excessive amount of transverse waves[1] should be avoided. These often require higher welding times than necessary or a higher pressure of the sonotrode to the workpiece and thus shortens the life of sonotrodes.

A good longitudinal vibration ensures a stable and uniform amplitude at the working surface of the sonotrode. Such an amplitude shows a uniform sinusoid on the oscilloscope.

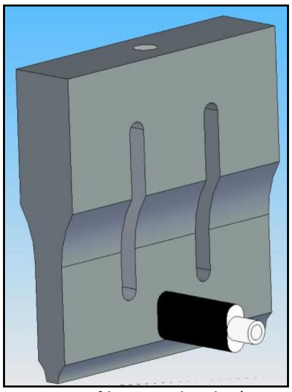


Transverse waves (schematically)

If the measured amplitudes of the transverse vibrations are greater or even significantly greater than about 30-50% of the amplitudes of the longitudinal vibrations, the sonotrode may not be optimally designed or manufactured. It will have a limited lifetime and may get hot; the idle power will be high and optimal welding results will not be achieved.



Measuring of transversal vibrations



Measuring of longitudinal vibrations

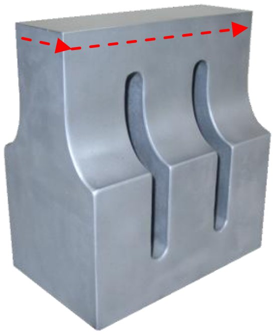
Basically, it can be expected that a well-working sonotrode produces a clean sinusoid. Significant deviations in the curve are an indication of errors.

[1] There are always small transverse vibrations in sonotrodes - it just should not be too many.

4.4.4 Amplitude distribution

It is important to choose the design of the sonotrode so that the amplitude distribution is as even as possible. There are a number of constructive options available.

With the USM 3.1, the amplitudes of the longitudinal and transverse vibrations on the outer edges of a sonotrode can be detected.



Use the measuring head to tap the flanks of the sonotrode on the work surface and observe the sinusoid on the oscilloscope. Fluctuations above the amplitude values above approx. 15% - 20% can be an indication of a non-optimal vibration behavior.